


# TERRESTRIAL LANDSCAPES AND AQUATIC ECOSYSTEMS: WHERE ARE THE RESTORATION TARGETS?

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November 18, 2009

# Aquatic Ecosystems and Terrestrial Landscapes are Linked



An aerial photograph showing a wide river that has formed by the confluence of several smaller streams. The river flows through a vast, dense forest of green trees. The water is a deep blue-grey color, and the surrounding land is covered in lush green vegetation. The sky is visible at the top, showing some light clouds.

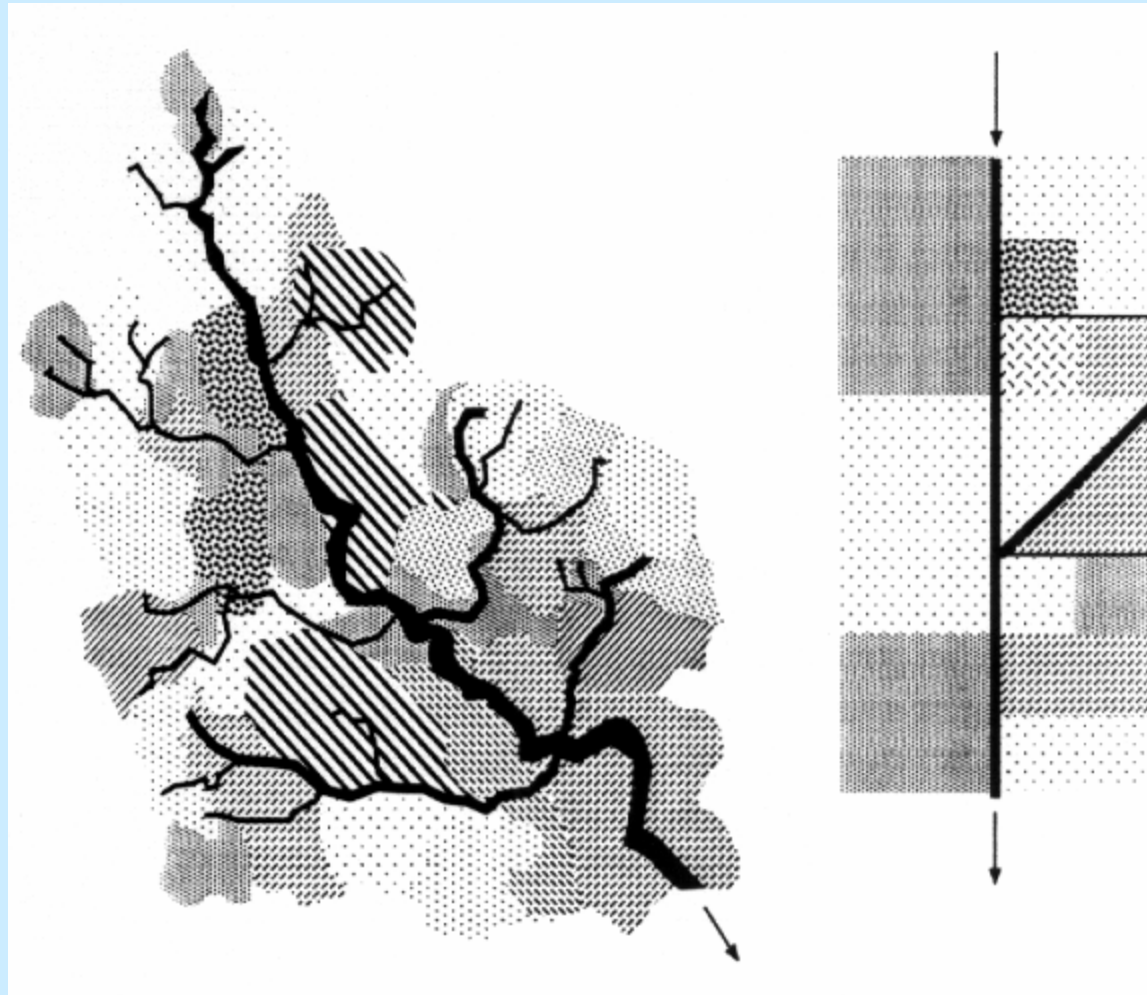
"Eventually, all things merge  
into one, and a river  
runs through it"  
-- Norman Maclean

# What does Landscape Ecology Have to Offer?

An aerial photograph showing a winding river or stream flowing through a landscape of agricultural fields. The fields are divided into various colored patches, likely representing different crops or land uses. The river is a prominent blue feature, meandering through the landscape. The text "Five General Principles" is overlaid in white on the river.

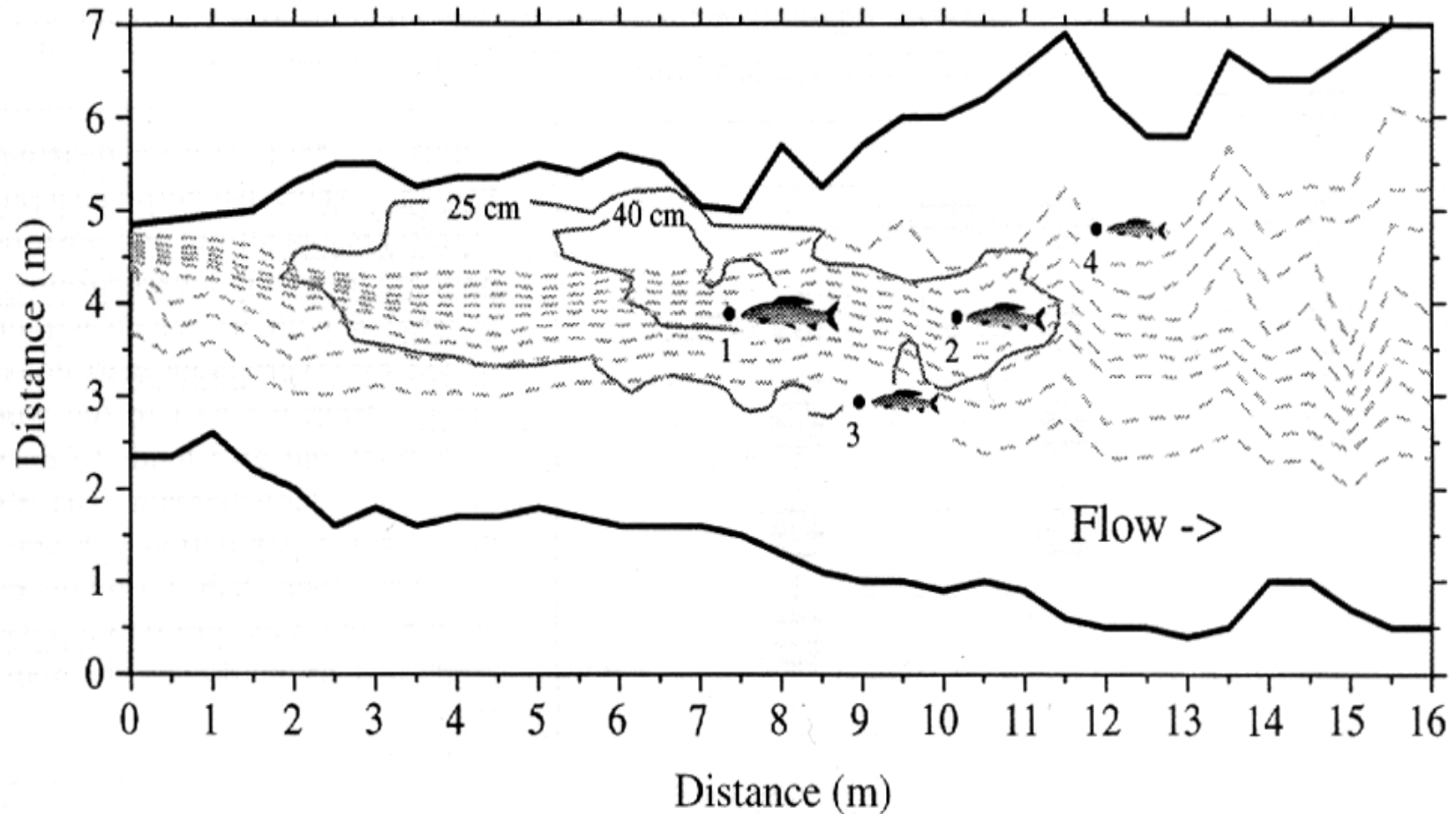
## Five General Principles

# Patch Context Matters

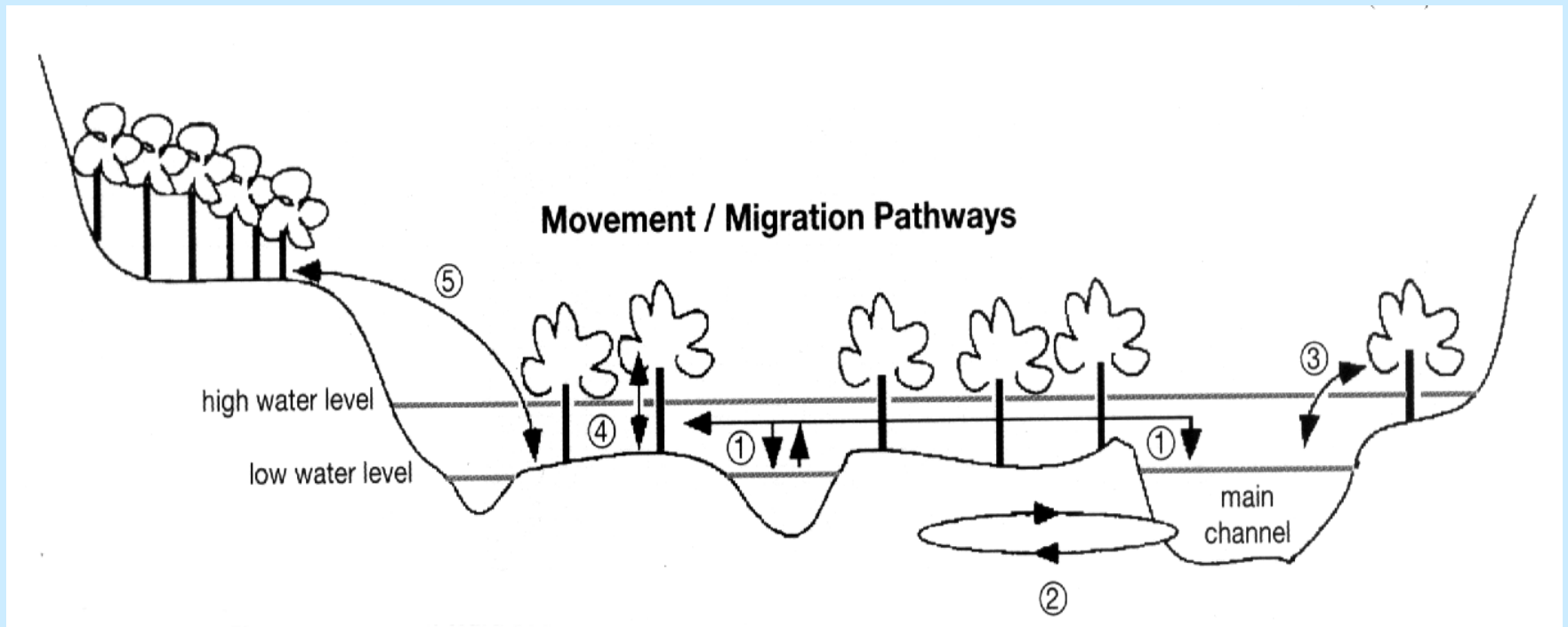




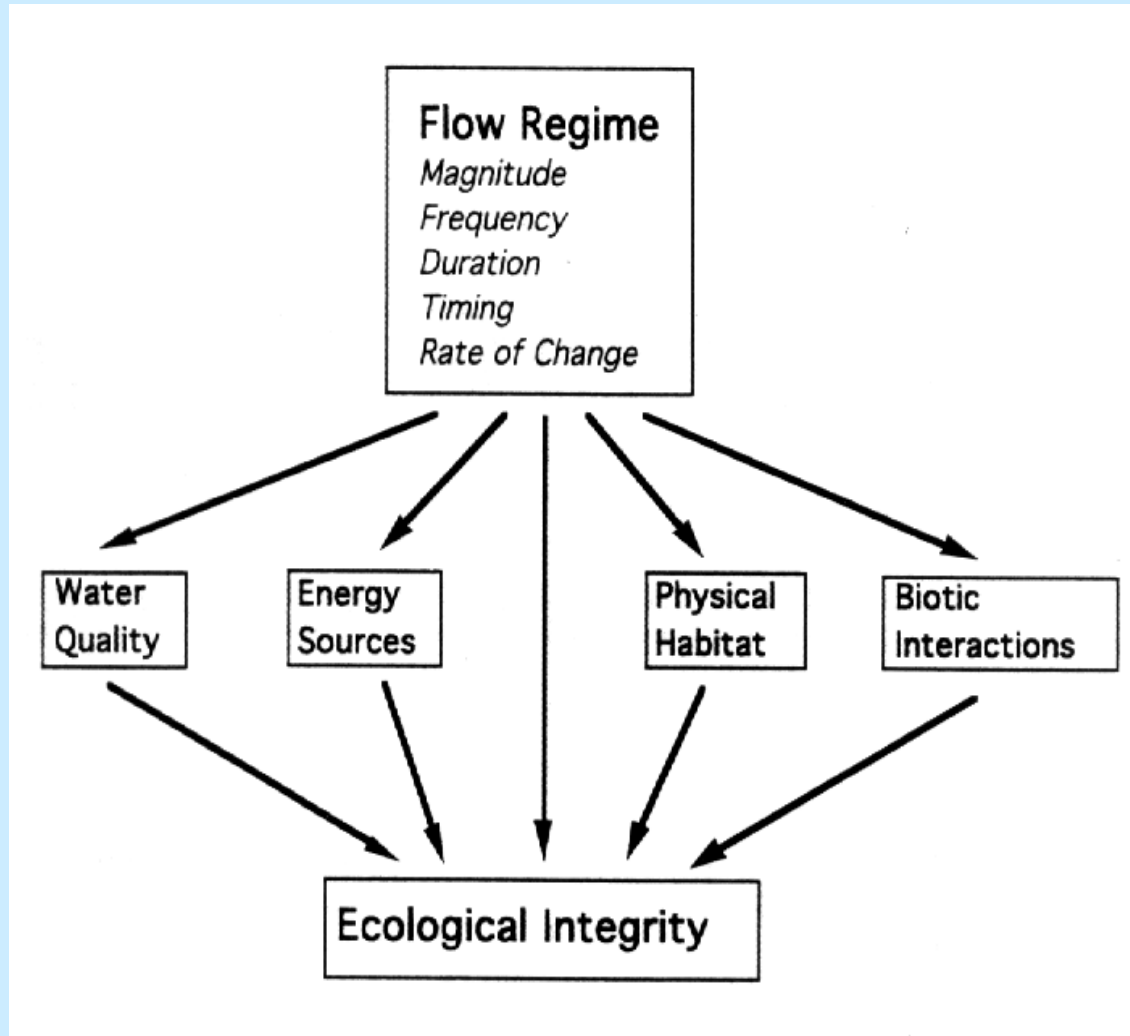
# Patches Differ in Quality



# Patch Boundaries Affect Flows

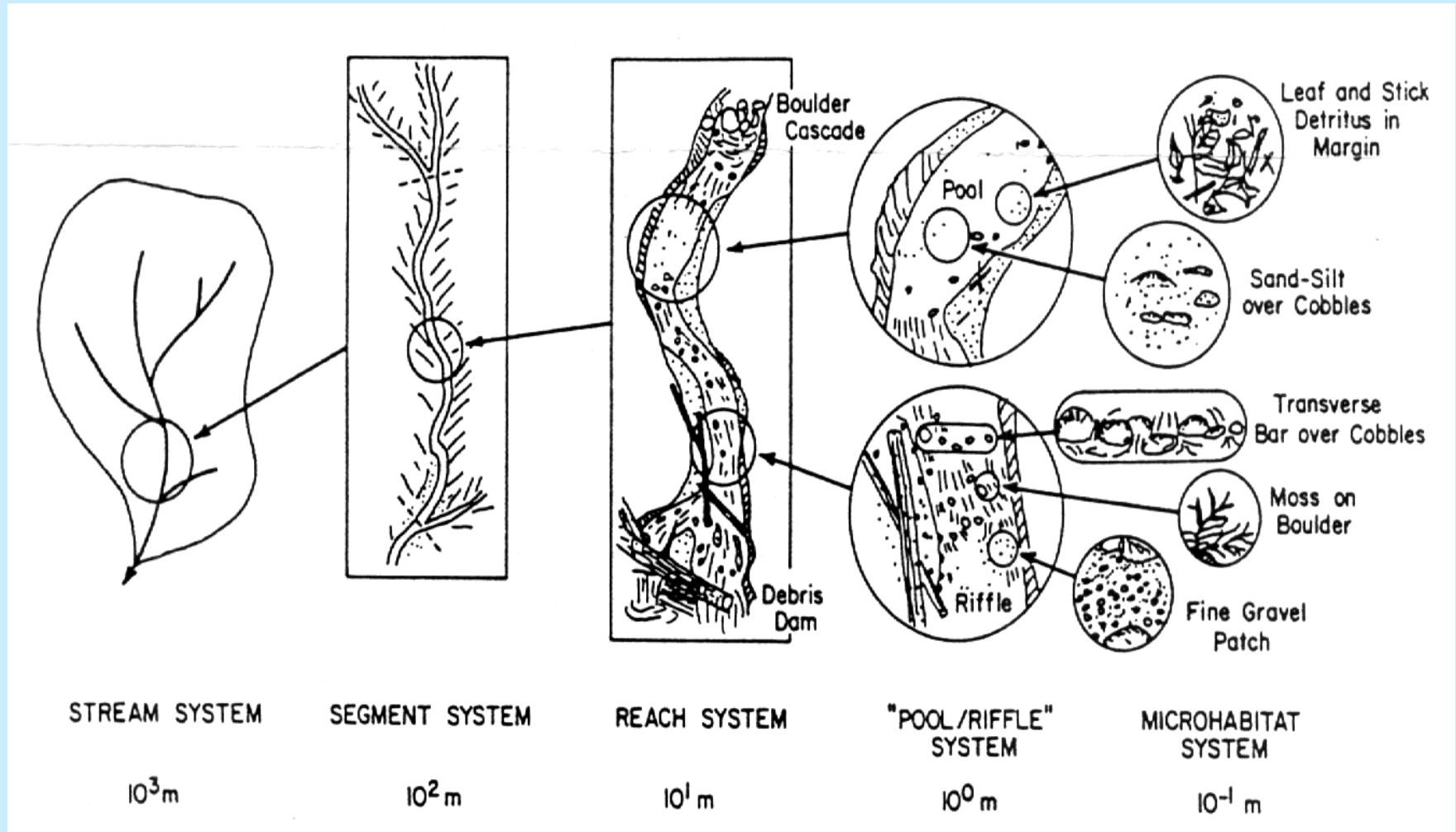


# Connectivity is Critical





# Scale Matters



# Restoration: Re-establishing Connections and Processes



# Sacramento River Riparian Restoration



Year 1 (2002)



Year 3 (2004)



Year 4 (2005)





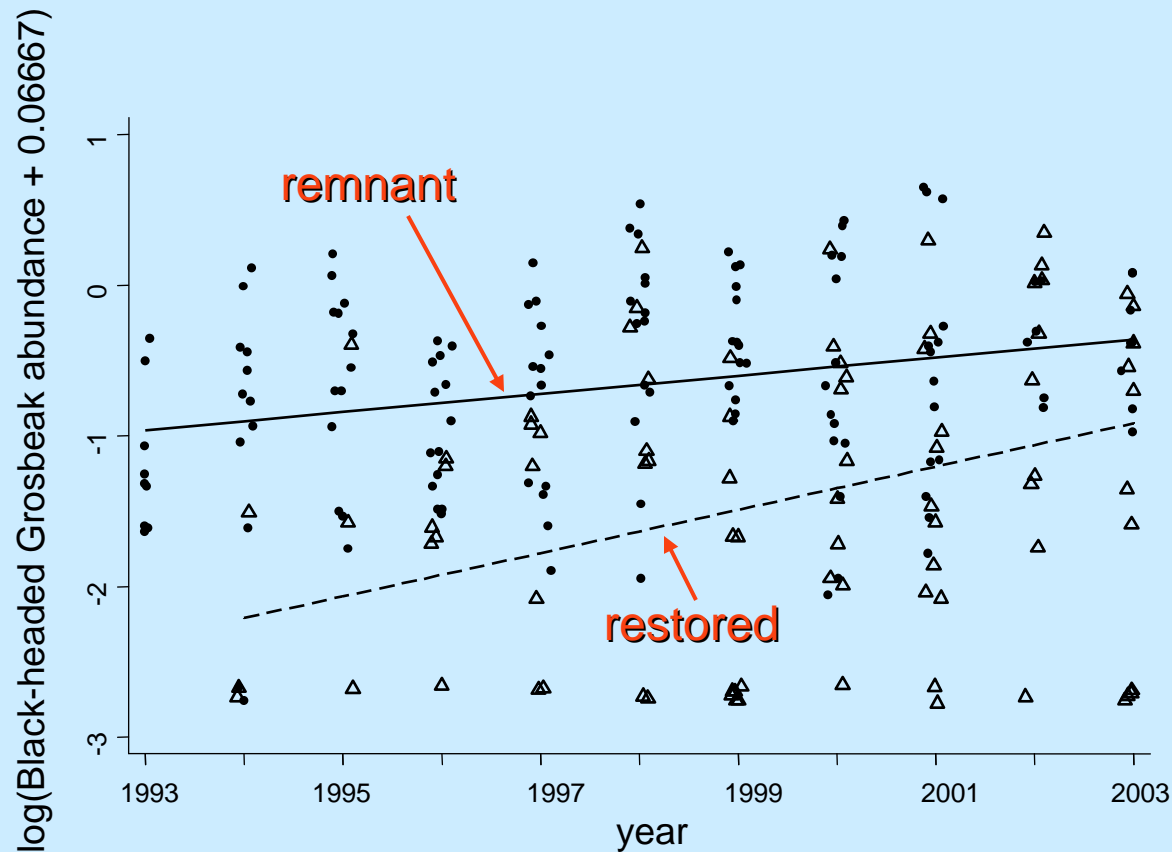
# Study Design

Restored

Remnant/Reference



# Black-headed Grosbeak Response to Restoration



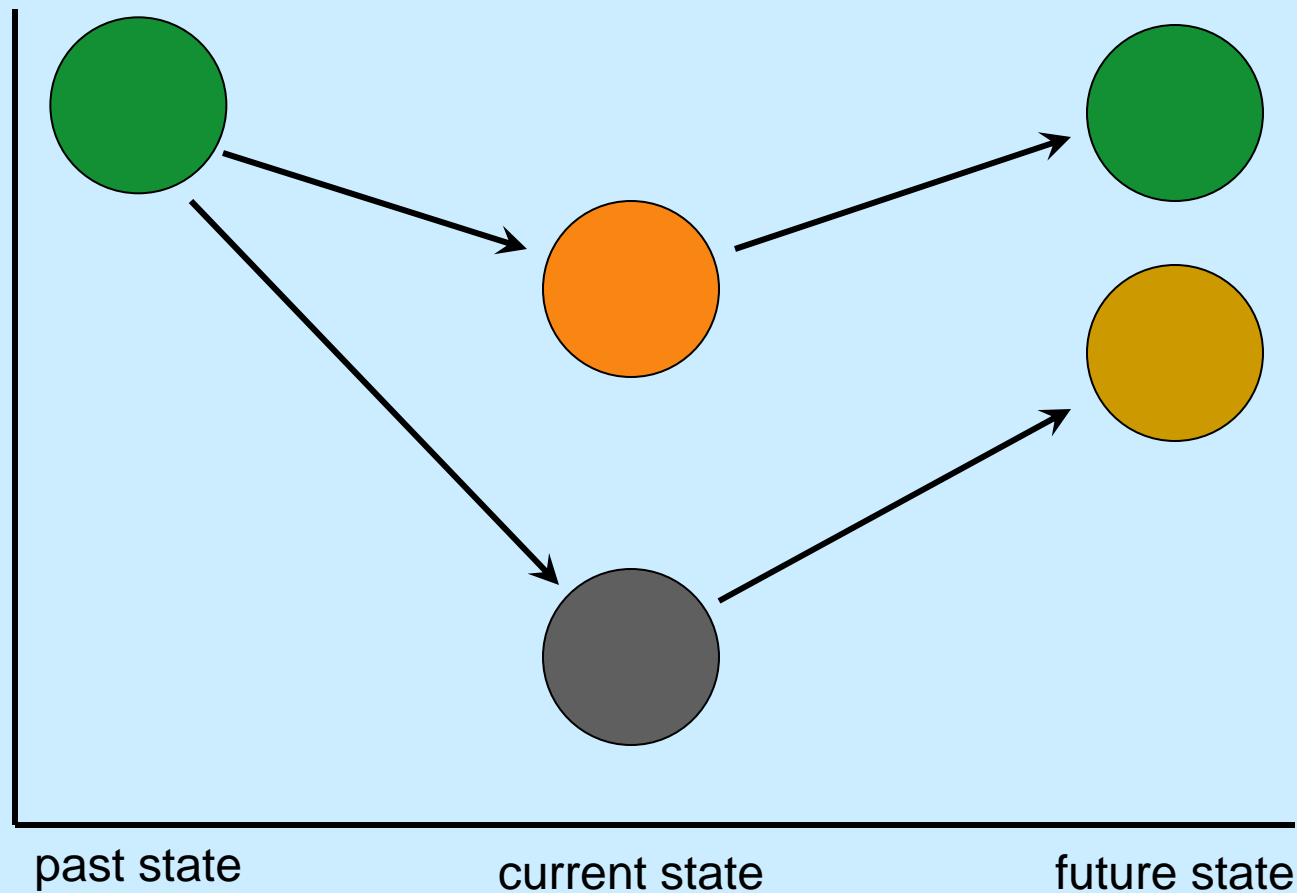
# Black-headed Grosbeak Habitat Models

MODEL	AIC	delta-AIC	AIC-w
<b>percent riparian 2km, # <i>tree species</i></b>	475.616	0	0.622
<b>percent riparian 2km, <i>willow</i></b>	478.695	3.079	0.133





# What are the Goals of Restoration?



# The Dilemma of Restoring At-Risk Species



# Conservation Reliant Species



Adapted to human environments

peregrine falcon

maintains populations under  
existing regulations

brown pelican

periodic management  
required

Kirtland's warbler

continuous management  
required

Hawaiian gallinule

maintained by captive  
releases

Attwater's prairie chicken

occurs only in  
captivity

Guam kingfisher



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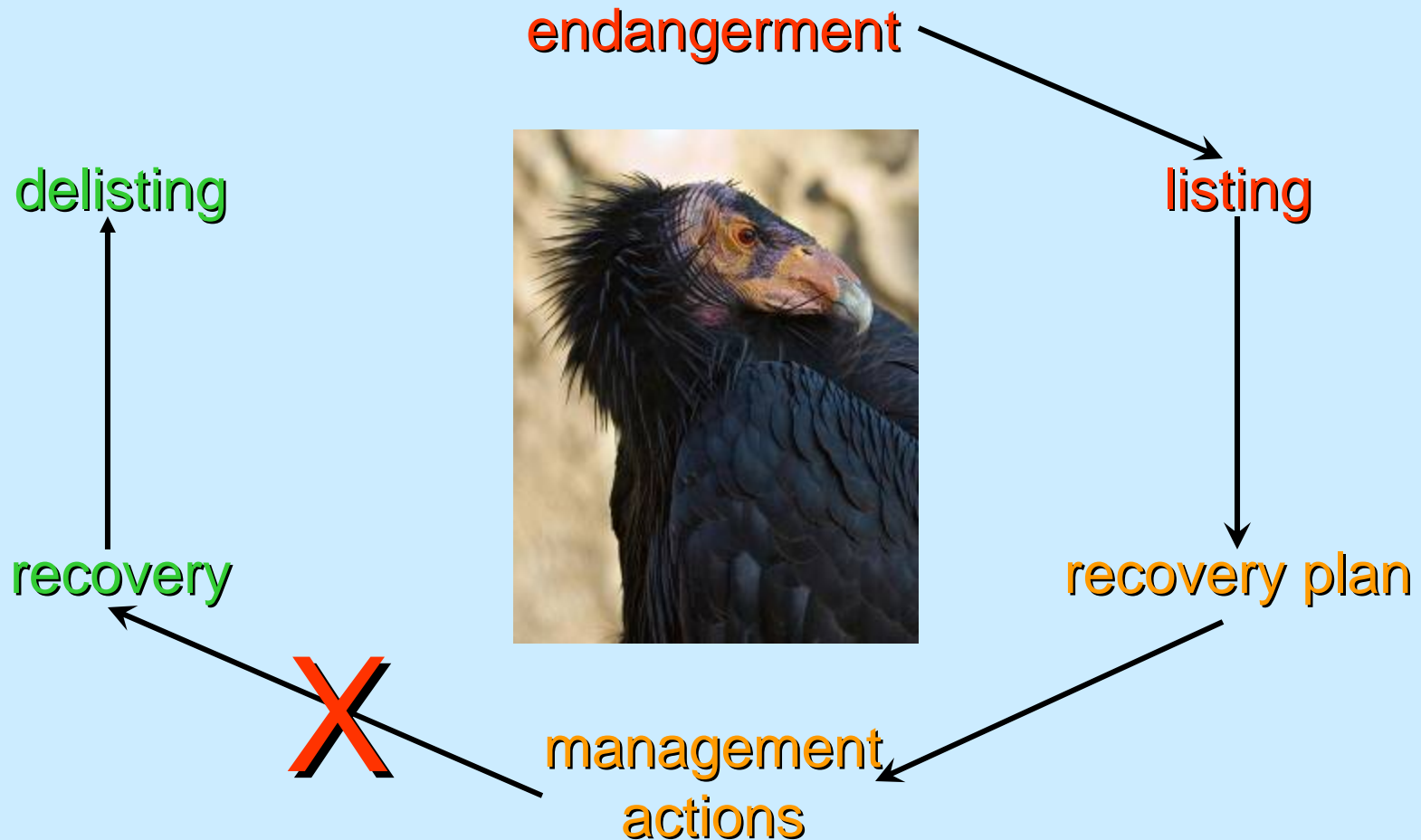
Attwater's prairie chicken

occurs only in  
captive

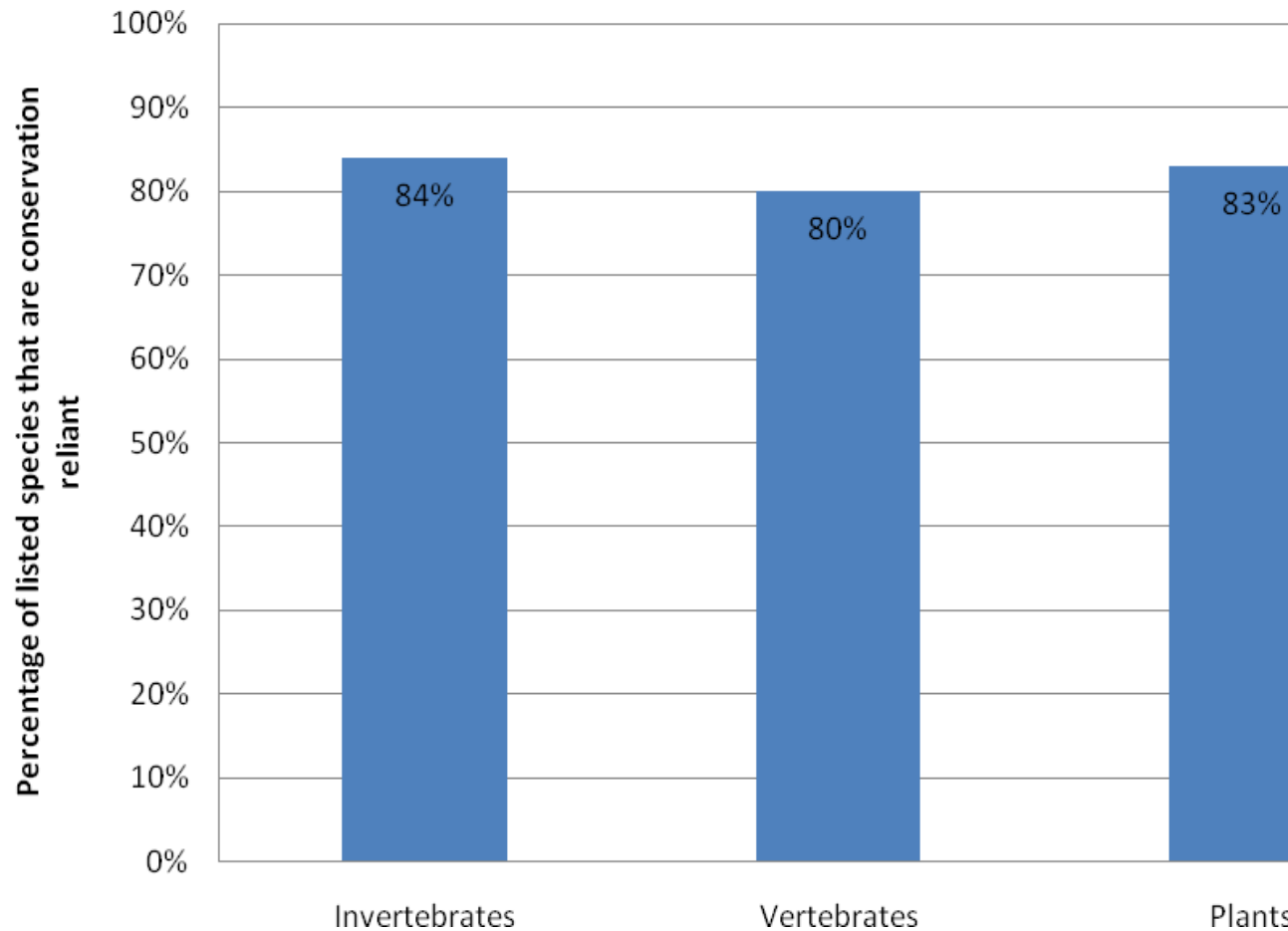
Guam kingfisher



# The Endangered Species Act

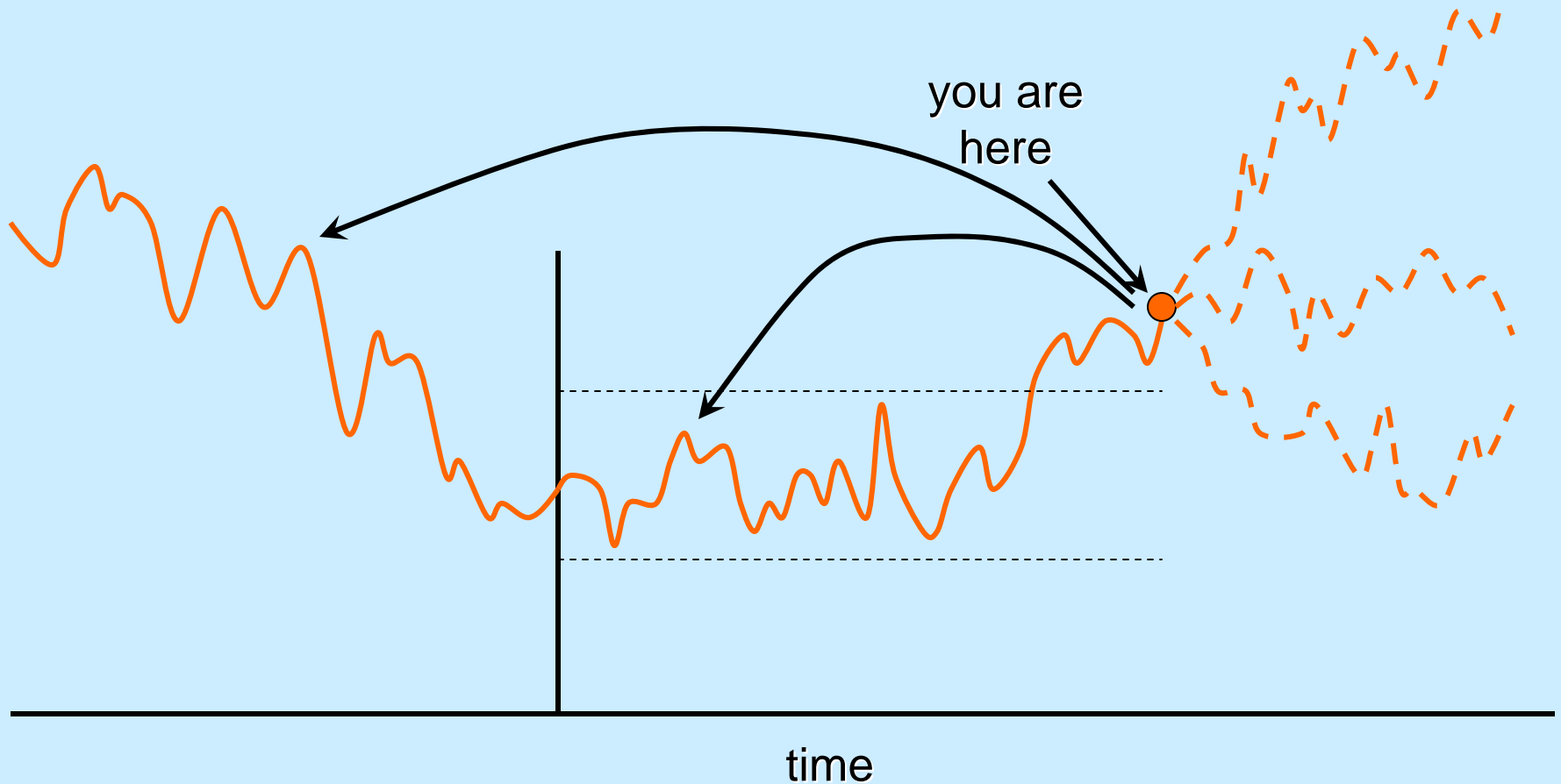


# How Many Threatened and Endangered Species are Conservation Reliant?

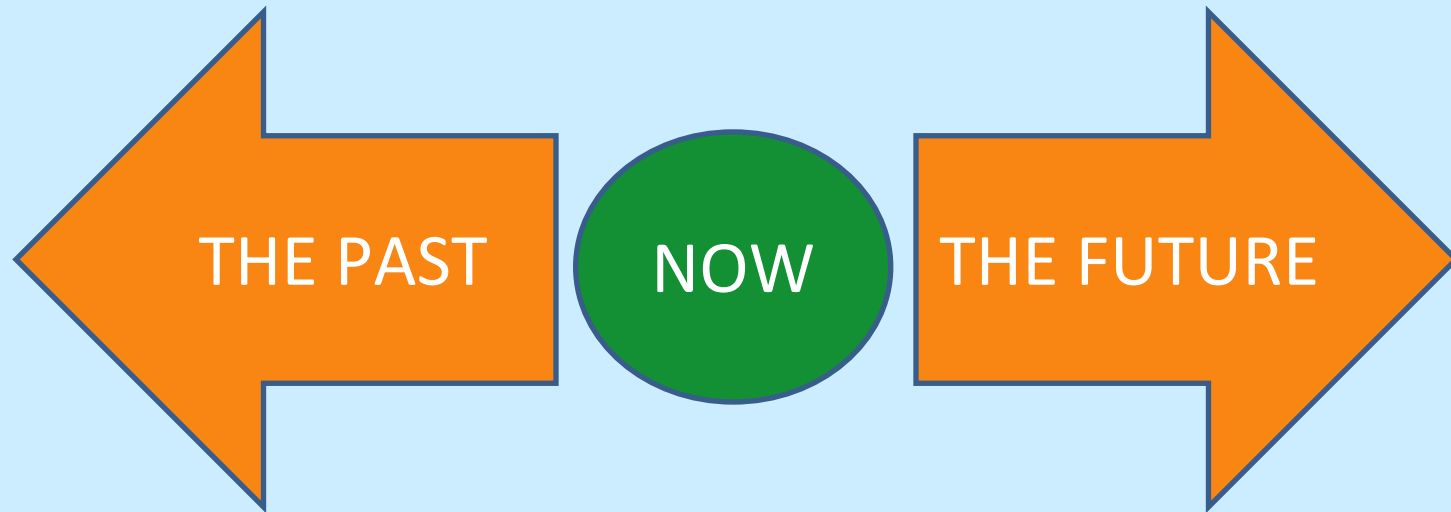




# Time Scales and Restoration Goals

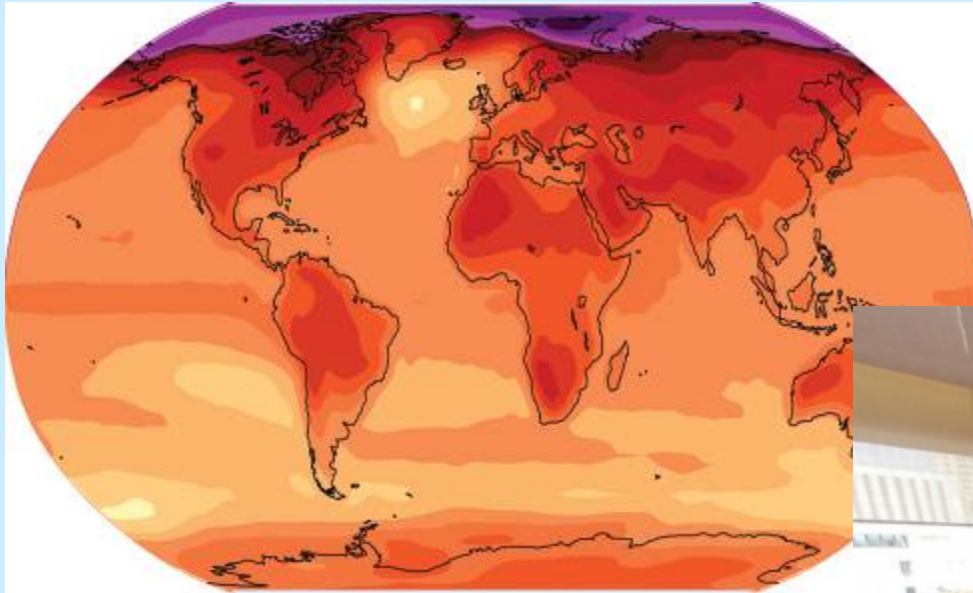


# Restoration Goals and Strategies



Restoration often has past (historic) systems as a goal, but also needs to consider future conditions

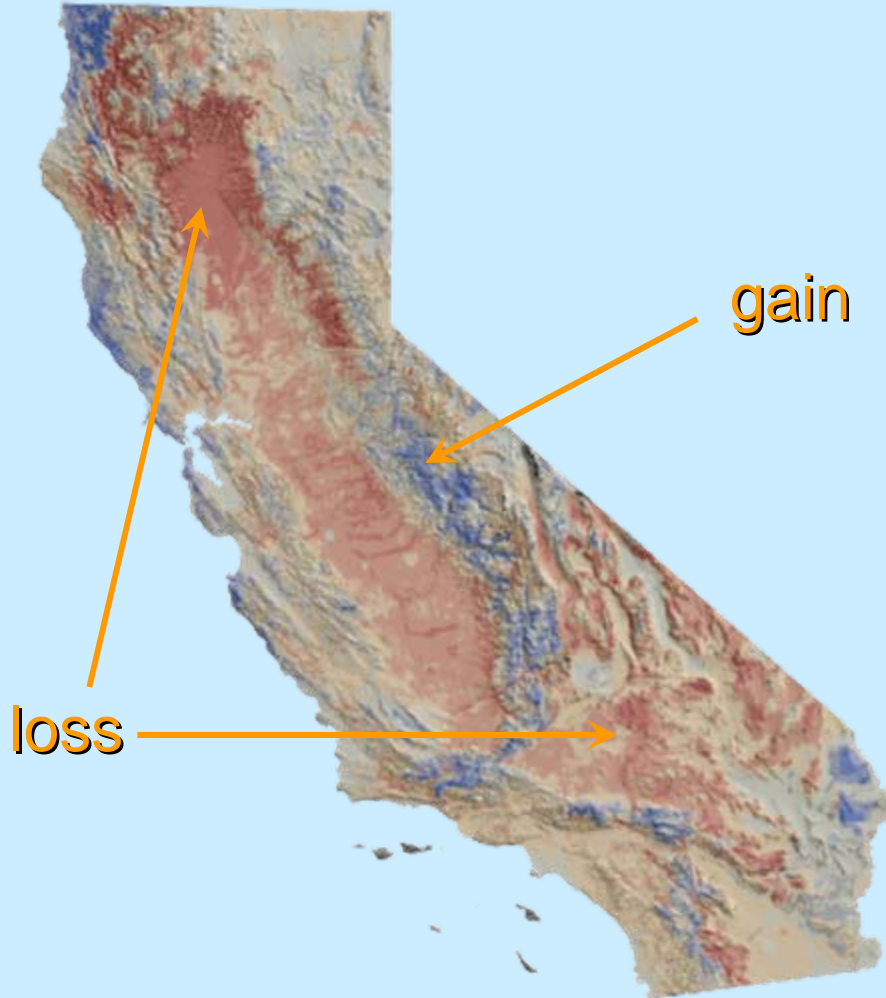
# Climate Change is the Elephant in the Room



# Hotspots of Change in Species Richness

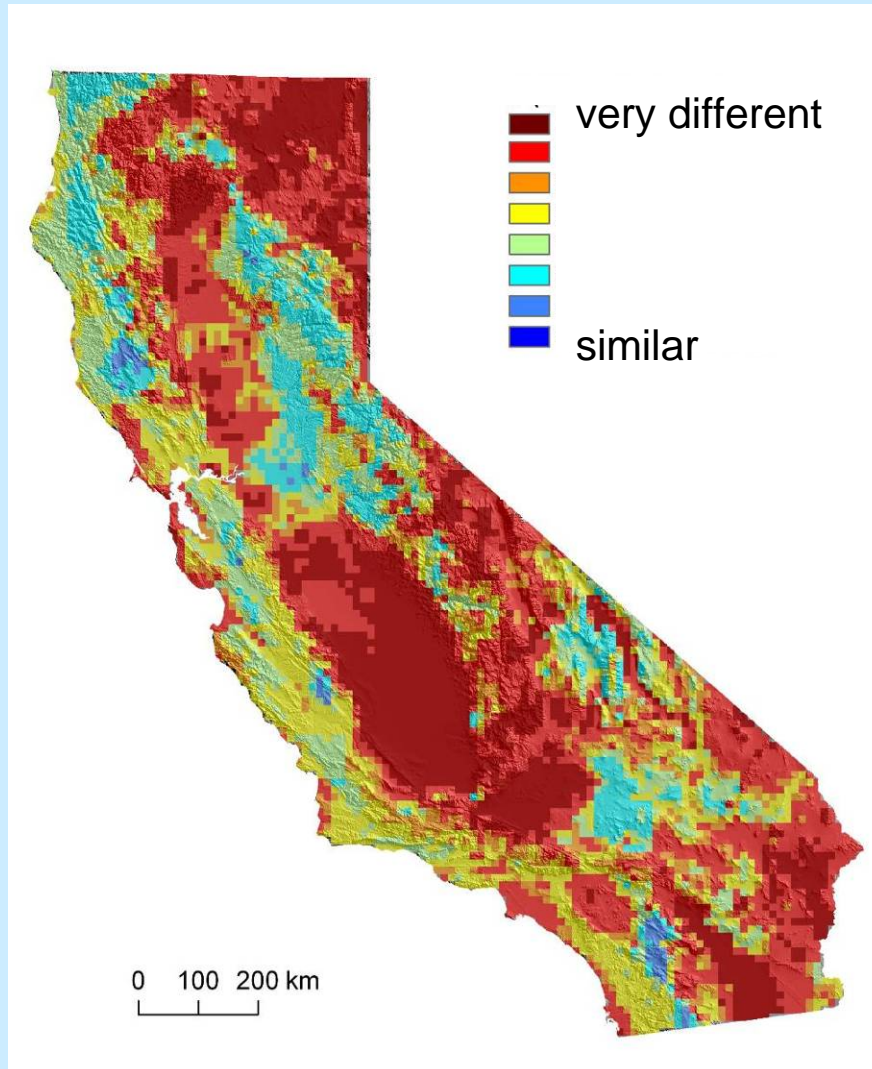


Wilson's Warbler



Oak Titmouse

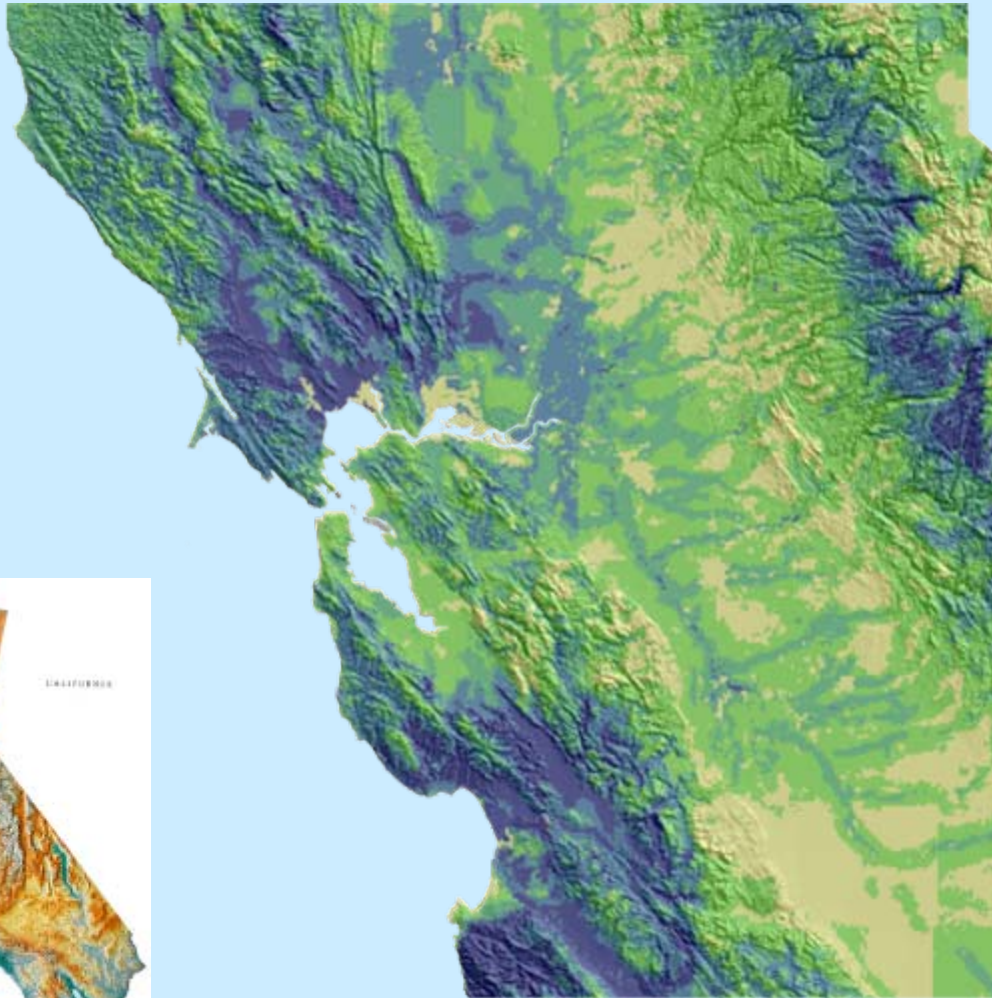
# “No-analog” Future Bird Assemblages



Many areas will contain assemblages that we have not seen before --- and that the species have not experienced before



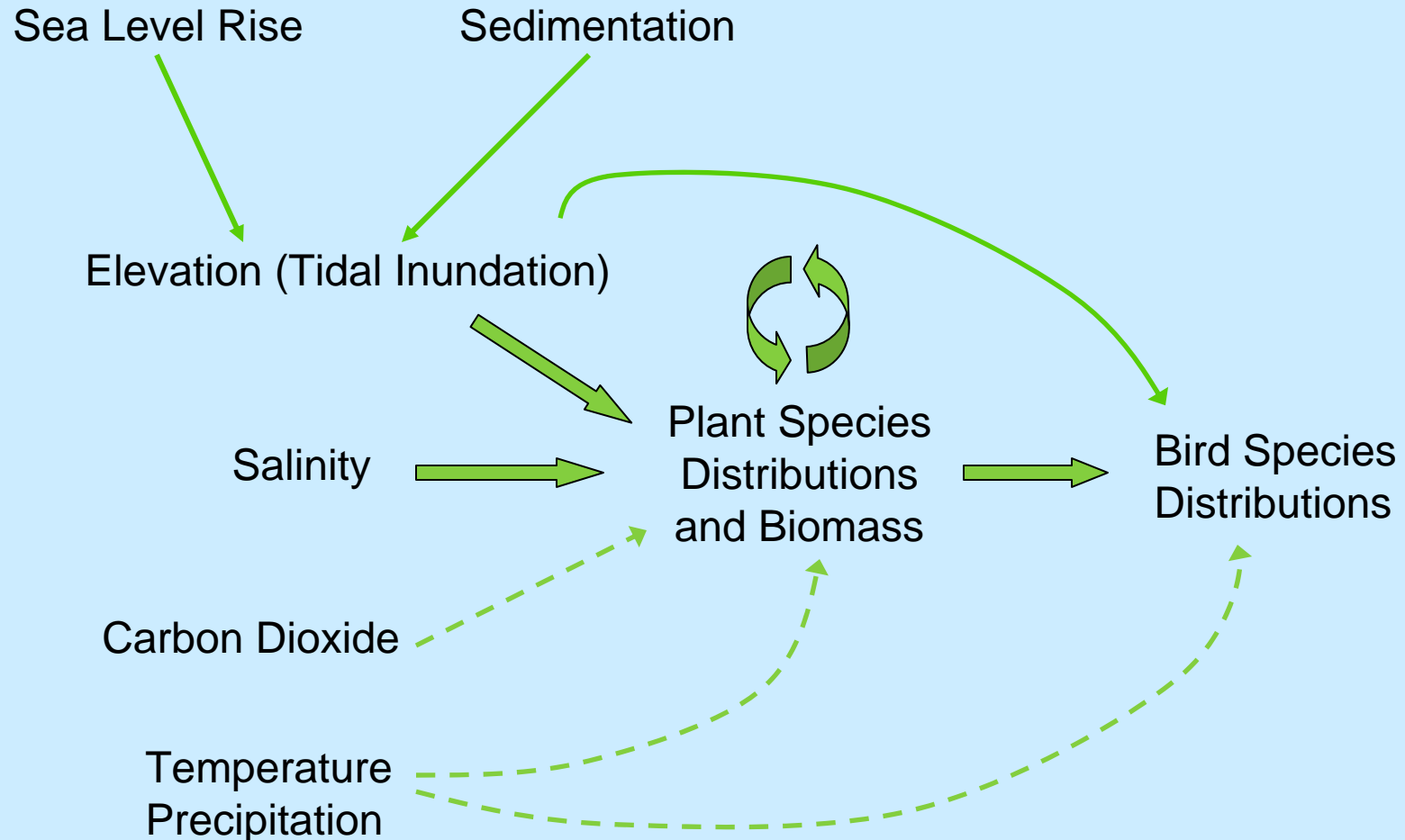
# Projected Distribution: Black-headed Grosbeak



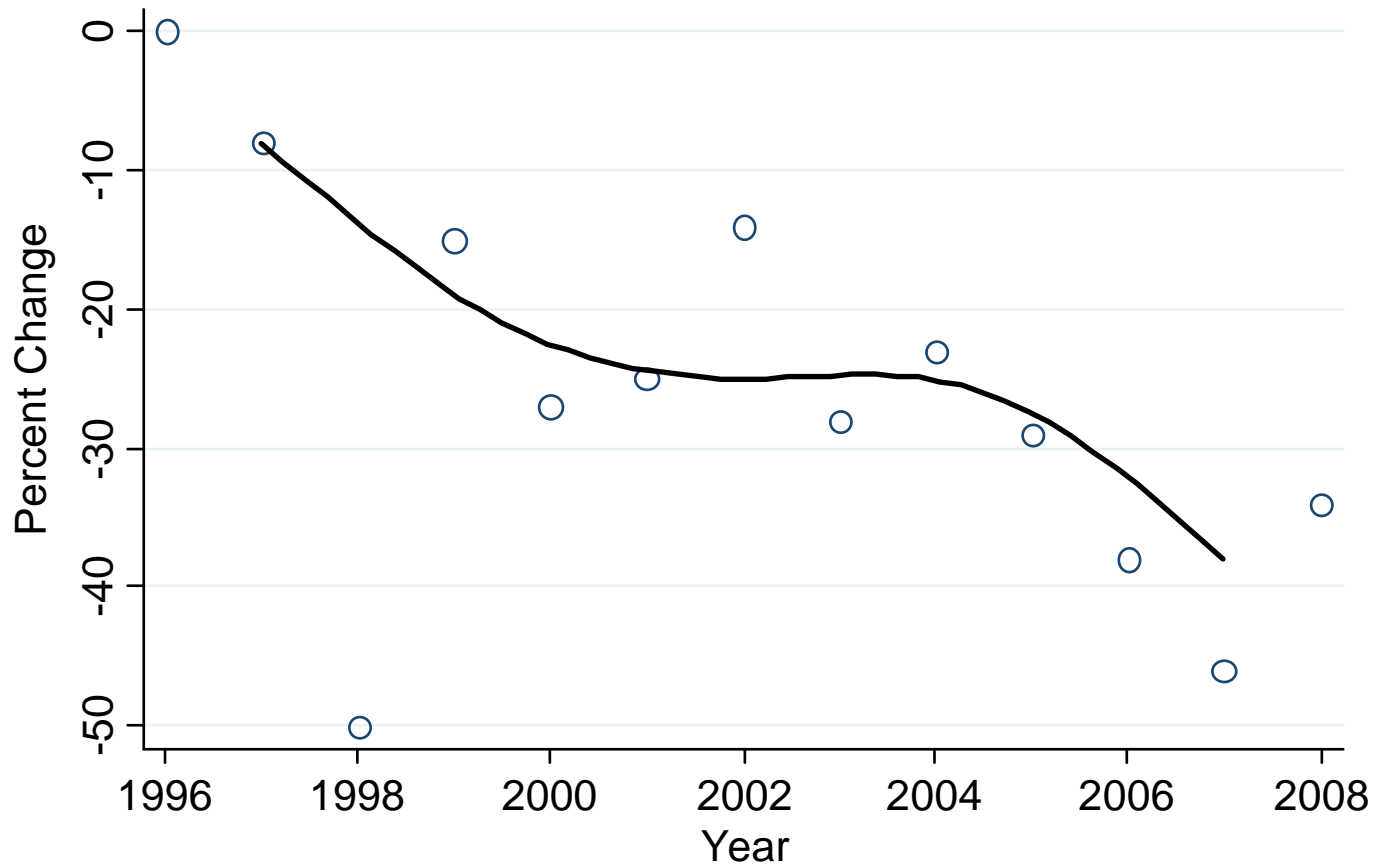
Source: D. Stralberg et al., PRBO, unpublished



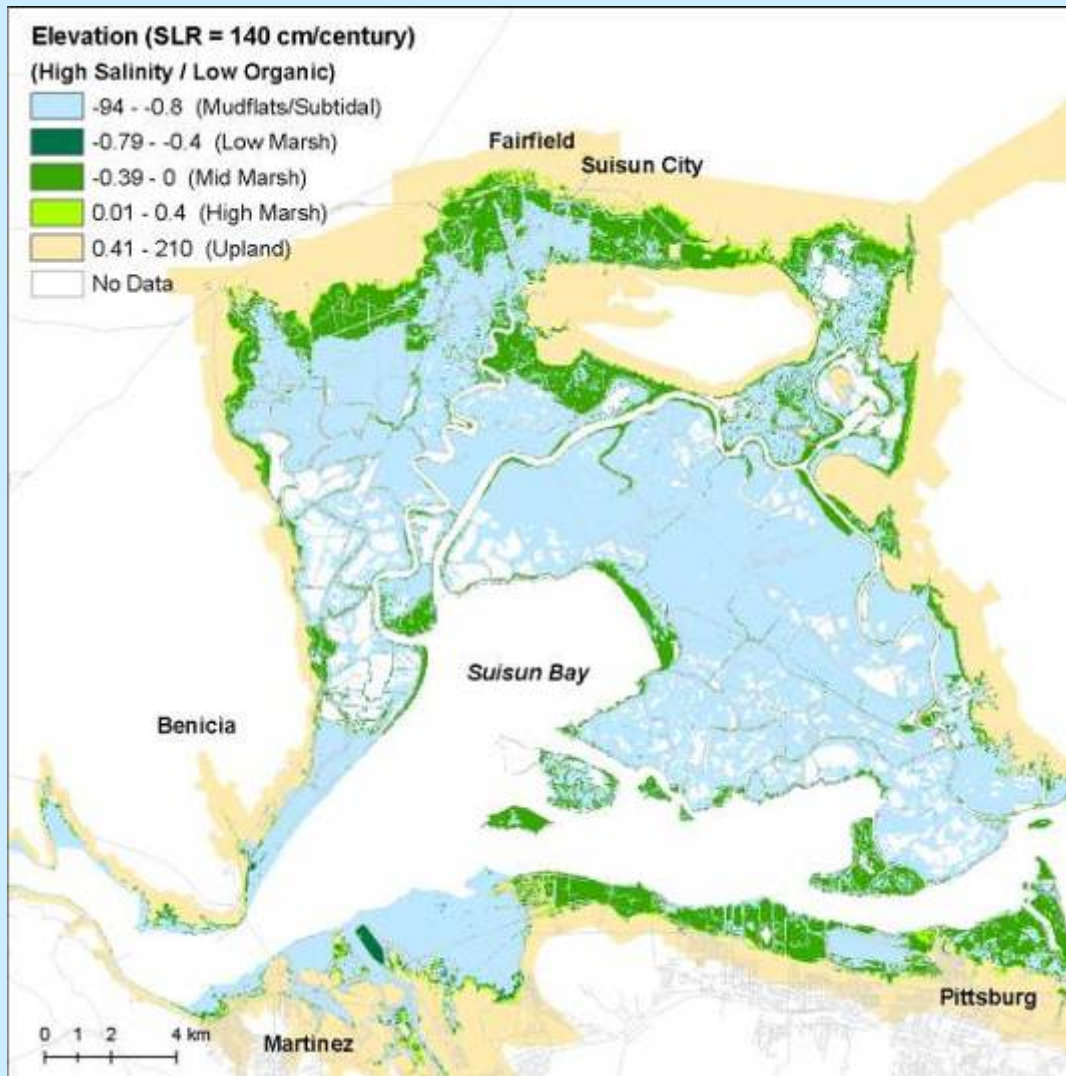
# Tidal Marsh Response to Sea Level Rise



# Song Sparrow Population Trends, Suisun Marsh



# Projected Elevation Changes: Suisun Marsh



**140 cm SLR**

Source: Stralberg et al. PRBO, in progress

# Management Strategies in a Changing Environment

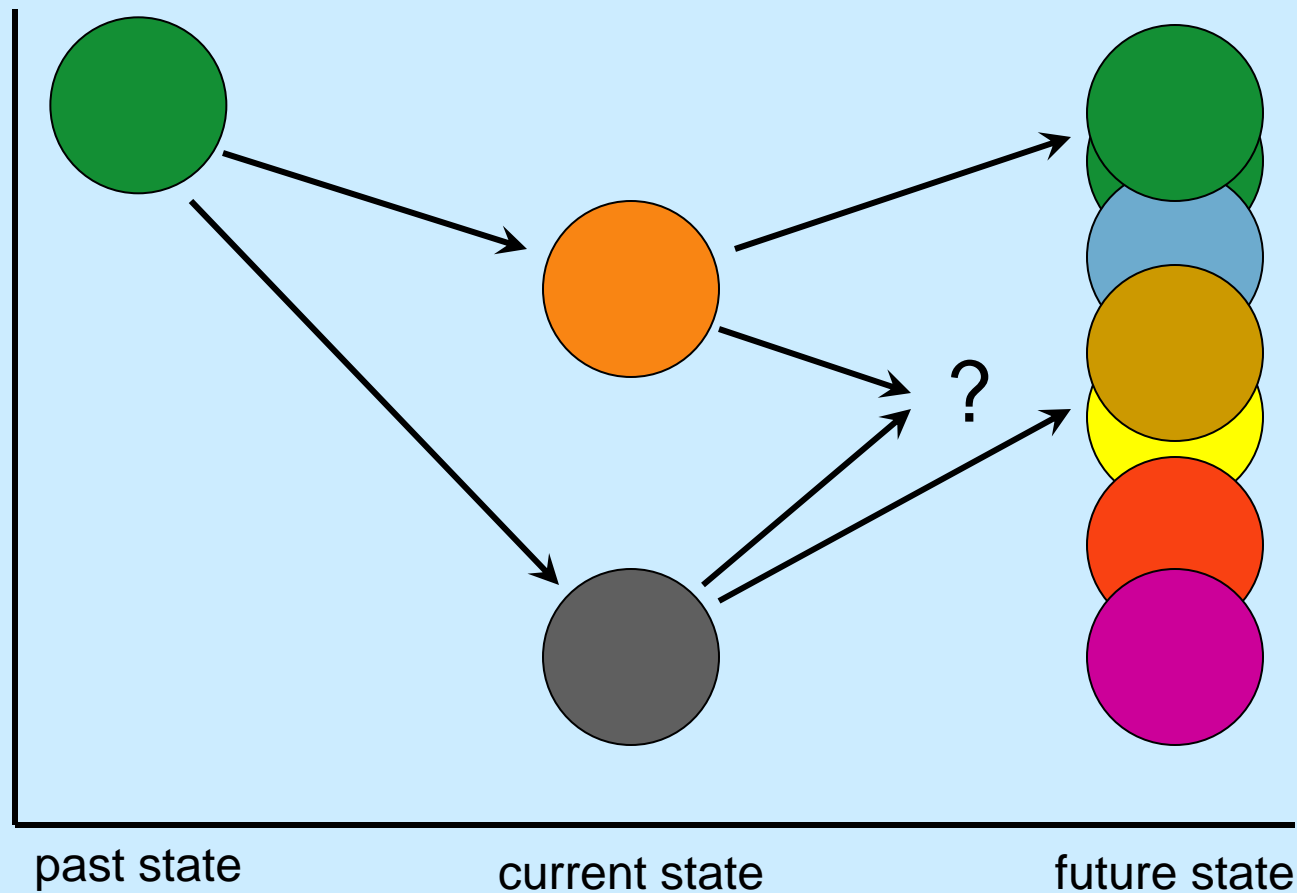
## GOALS

- Resistance
- Resilience
- Response

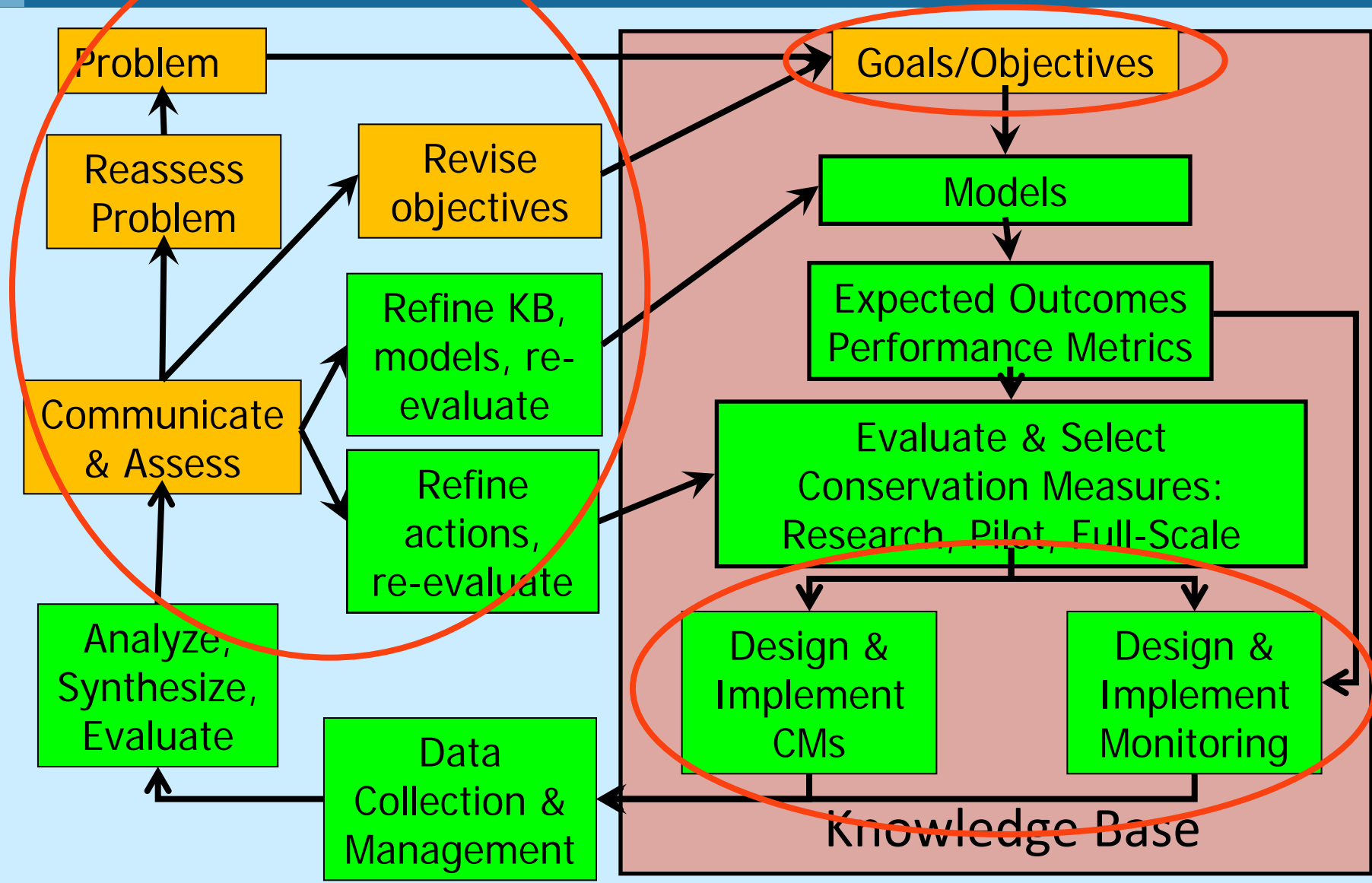
## STRATEGIES

enhance connectivity  
promote redundancy and buffers  
reduce landscape synchrony  
realign disrupted conditions  
expect surprises  
identify and protect refugia

# What are the Goals of Restoration?



# Implementing Adaptive Management





# A Final Thought

“Sometimes, if you stand on the bottom rail of a bridge and lean over to watch the river slipping slowly away beneath you, you will suddenly know everything there is to be known.”

- Winnie-the-pooh  
(A.A. Milne)



# Acknowledgments

## PRBO

- Diana Stralberg
- Dennis Jongsomjit
- Chrissy Howell
- Tom Gardali
- Nat Seavy

## Others

- Steve Crooks (PWA)
- Mark Snyder (UC Santa Cruz)
- Richard Hobbs (Univ. Western Australia)
- Our Funders and Supporters



Jules Evens